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Table 1

Acc # 1-Vehicle Motion  
 Acc # 2-Wheel Angle  
 Light Sensor - Ambient  
 Temp Sensor - Ambient  
 Sounder  
 Mark Button

Table 2

W - Wheel Rotation Angle  
 X - Measured component of g in sensor axis (m/s/s)  
 K wheel - Sensor scaling factor (mm/s/s/bit)  
 g - Gravity 9.81 m/s/s  
 g - Gravity Vector Component in wheel Plane

$\sin W = X / g$

$X = k \text{ wheel} / 1000 \times (\text{Ch}(1) - \text{ZeroWheel}) \times 1/\cos(\text{Alpha})$

$\sin W = k \text{ wheel} / (1000 \times g) \times (\text{Ch}(1) - \text{ZeroWheel}) \times 1/\cos(\text{Alpha})$

$W + \text{ArcSin} [K\text{wheel} / (1000 \times g) \times (\text{Ch}(1) - \text{ZeroWheel}) \times 1/\cos(\text{Alpha})]$

Table 3

$$\text{RMS Steering Angle- } R(\text{Deg}) = \sqrt{\frac{\sum \text{Wheel}[n]^2}{n}}$$

Table 4

Bound Check

W Limit- < W < W Limit+  
 W < W Limit-  
 W > W Limit+

Steering Mode=Corrective  
 Steering Mode=Active  
 Steering Mode=Active

Table 5

$$\text{RMS Vehicle Acceleration-G(m/s/s)} = \sqrt{\frac{\sum \text{Acc}[n]^2}{n}}$$

Table 6

<p>T cycle = 60s T monitor = 50s T process = 10s</p>	<p>Calculate Parameters Test &amp; Issue Warnings Update Screen Display Store Sensor Data &gt; Disk Store Calculated Parameters &gt; Disk</p>
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Table 7

Note:  
Data storage @ 1Hz  
ZeroAcc=Average {RawAcc[n]}  
ZeroWheel=Average {RawWheel[n]}  
Ch(N)=Raw ADC Value (bit)

Table 8

$\text{Acc}[n] = \text{Kacc}/1000 \times (\text{RawAcc}[n] - \text{ZeroAcc}) \times 1/\text{Cos}(\text{Alpha})$			
(m/s/s)	(mm/s/s/bit)	(bit)	(bit)
$\text{Wheel}[n] = \text{ArcSin} [ \text{Kwheel}/(1000 \times 9.81) \times (\text{RawWheel}[n] - \text{ZeroWheel}) \times 1/\text{Cos}(\text{Alpha}) ]$			
(Deg)	(mm/s/s/bit)	(bit)	(bit)
$I = \text{Klight}/1000 \times (\text{Ch}(2) - \text{ZeroLight})$			
(KLx)	(Lx/bit)	(bit)	(bit)
$T = \text{Ktemp}/1000 \times (\text{Ch}(3) - \text{ZeroTemp})$			
(DegC)	(mDegC/bit)	(bit)	(bit)

Table 9

Engineering Scaling Factors	
K acc (mm/s/s/bit)	Acceleration Channel
K wheel (mm/s/s/bit)	Steering Channel
K light (Lx/bit)	Light Channel
K temp (mDegC/bit)	Temp Channel
ZeroLight (bit)	Intercept adjust - Light
ZeroTemp (bit)	Intercept adjust - Temp
Alpha (Deg)	Steering Wheel Inclination from Vertical
Hysterisis (Deg)	Hesterisis factor - Zero X analysis

Table 10

Sleep Propensity Algorithm - Definition	
$S_{mod} = S_{circ} + S_{zerox} + S_{rms} + S_{light} + S_{temp} + S_{sleep} + S_{road} + S_{trip}$	
Elemental	Bound Limit
$S_{mod}$	$0 < S_{mod} < 1$
$S_{circ}$	$0 < S_{circ} < 1$
$S_{zerox} = (F_{zerox}/100) (Z_{ref} - Z)$	$0 < S_{zerox}$
$S_{rms} = (F_{rms}/100) (R - R_{ref})$	$0 < S_{rms}$
$S_{light} = (F_{light}/100) (I_{ref} - I)$	$0 < S_{light}$
$S_{temp} = (F_{temp}/100) (T - T_{ref})$	$0 < S_{temp}$
$S_{sleep} = (F_{sleep}/100) (H_{ref} - (H \times Q))$	$0 < S_{sleep}$
$S_{road} = (F_{road}/100) (G_{ref} - G)$	$0 < S_{road}$
$S_{trip} = (F_{trip}/100) \times D$	$0 < S_{trip}$

Table 11

Algorithm Elementals - S	
$S_{mod} (S)$	Modified Sleep Propensity Factor-Range 0...1
$S_{circ} (S)$	Current Circadian Sleep Propensity Value
$S_{zerox} (S)$	Current Corrective Steering Reversal Rate Deficit
$S_{rms} (S)$	Current RMS Corrective Steering Amplitude Surfit
$S_{light} (S)$	Current Ambient Lighting Intensity Deficit
$S_{temp} (S)$	Current Ambient Temperature Surfit
$S_{sleep} (S)$	Prior Sleep Good Hours Deficit
$S_{road} (S)$	Current Road Activity Deficit
$S_{trip} (S)$	Accumulated Trip Duration

Table 12

**Algorithm Weighting Factors - F**

Note : Factors are % S Unit per Parameter Unit

F zerox (%S/#/min)	Corrective Steering Reversal Rate Deficit - % Factor
F rms (%S/Deg)	RMS Corrective Steering Amplitude Surfit - % Factor
F light (%S/kLx)	Average Ambient Lighting Intensity Deficit - % Factor
F temp (%S/DegC)	Average Ambient Temperature Surfit - % Factor
F sleep (%S/Hr)	Prior to Good Hours Sleep Deficit - % Factor
F road (%S/m/s/s)	Road Activity Deficit - % Factor
F trip (%S/Hr)	Accumulated Trip Duration - % Factor

Table 13

**Algorithm Reference Offsets - ref**

Z ref (#/min)	Corrective Steering Reversal Rate - Ref Offset
	Corresponds to 'Alert' Driving Subject Dependent
R ref (Deg)	Corrective Steering RMS Amplitude - Ref Offset
	Corresponds to 'Alert' Driving Subject Dependent
I ref (kLx)	Average Ambient Lighting Intensity - Ref Offset
	Corresponds to moderate daylight
T ref (DegC)	Average Ambient Temperature - Ref Offset
	Corresponds to moderate environment
H ref (Hr)	Prior to Good Hours Sleep - Ref Offset
	Corresponds to optimum value
G ref (m/s/s)	Road Activity - RMS Acceleration / Deceleration - Ref Offset

Table 14

<b>Algorithm Dynamic Variables</b>	
Z (#/min)	Current Corrective Steering Zero X Rate
R (Deg)	Current RMS Corrective Steering Amplitude
I (kLx)	Current Ambient Lighting Intensity
T(DegC)	Current Ambient Temperature
G (m/s/s)	Current Road Activity - RMS Acceleration / Deceleration
D(Hr)	Accumulated Trip Duration
H(Hr)	Actual Hours of Prior Sleep
Q (#)	Prior Sleep Quality - Normalised Scale 0...1
Qx (#)	Prior Sleep Quality User Scale 1,2,3,4,5 $Q=Qx/5$

Table 15

<b>Steering Mode &amp; Steering Limit -W limit</b>	
W limit (Deg)	Decision limit - Steering mode detection +W limit >W> -W limit >>> Corrective +W limit <W< -W limit >>> Active
Steering Mode	Steering mode decision ACTIVE, CORRECTIVE

Table 16

<b>Alarm Levels &amp; Alarm State</b>	
Alarm Level 1 (s)	Alarm level threshold
Alarm Level 2 (s)	Alarm level threshold
Alarm Level 3 (s)	Alarm level threshold
Alarm Holdoff (min)	Initial alarm forced hold-off time - N minutes
Alarm State	Alarm status decision CLEAR, LEVEL1, LEVEL2, LEVEL3, HOLDOFF

Table 17

<b>User Software Functions</b>	
<b>Set Display Parameters</b>	
Enter New Values and <RET> or <RET> to bypass edit option.	
Display History (min)	Graphic display history length - Last N minutes
FSD (S)	Graphic display full scale - S unit (0.. 1)

Table 18

<b>Data Directory Structure</b>	
[ALGO]*.ALG	Algorithm Data Files - Internal Format
[USER]*.ALG	User Data Files - Internal Format
[XALGO]*.CSV	Algorithm Data Files - CSV Format
[XUSER]*.CSV	User Data Files - CSV Format
[XDRIVE]*.CSV	Drive Mode Data Files - CSV Format
[XLEARN]*.CSV	Learn Mode Data Files - CSV Format

Table 19

**File Structure - Program Internal Format**

Note : These files in program internal readable format

Configuration File - SLEEPALT.CFG

Save Set Values @ Program Shut Down

Load Set Value @ Program Initialisation

K acc (mm/s/s/bit)

K wheel (mm/s/s/bit)

K light (Lx/bit)

K temp (mDegC/bit)

K batt (mV/bit)

ZeroLight (bit)

ZeroTemp (bit)

Hysteresis (Deg)

Alpha (Deg)

AlgorithmID

UserID

Circ[0] ... [23] (S)

FSD (0.. 1)

DisplayHist (min)



Table 20

Algorithm Data File [ALGO]*.ALG	
F zerox	(%S/#/min)
F rms	(%S/Deg)
F light	(%S/Klx)
F temp	(%S/DegC)
F sleep	(%S/Hr)
F road	(%S/m/s/s)
F trip	(%s/Hr)
Z ref	(#/min)
R ref	(Deg)
I ref	(KLx)
T ref	(DegC)
H ref	(Hr)
G ref	(m/s/s)
Alarm1	(s)
Alarm2	(s)
Alarm3	(s)
AlarmHoldoff	(min)
W limit	(Deg)

Table 21

User Data File [USER]*.USR	
UserName	
UserDoB	
UserSex	

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Table 24

**Data File Structure - Algorithm Data File [XALGO]\*.CSV**

Note : These files in external readable format - CSV

AlgorithmID

File Creation Date

F zerox (%S/#/min)

F rms (%S/Deg)

F light (%S/kLx)

F temp (%S/DegC)

F sleep (%S/Hr)

F road (%S/m/s/s)

F trip (%S/Hr)

Z ref (#/min)

R ref (Deg)

I ref (KLx)

T ref (DegC)

H ref (Hr)

G ref (m/s/s)

Alarm1 (s)

Alarm2 (s)

Alarm3 (s)

AlarmHoldOff (min)

W limit (Deg)

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Table 22

**Data File Structure - Drive Mode Data File [XDRIVE]\*.CSV**

Note: These files in external readable format - CSV

DriveID

File Ceation Date

Start Time (Hr 0.. 23)

Start Time (min 0.. 59)

UserID

AlgorithmID

Alarm1 (s)

Alarm2 (s)

Alarm3 (s)

AlarmHoldOff (min)

W limit (Deg)

H (Hr)

Q (0.. 1)

F zerox (%S/#/min)

F rms (%S/Deg)

F light (%S/kLx)

F temp (%S/DegC)

F sleep (%S/Hr)

F road (%S/m/s/s)

F trip (%S/Hr)

Z ref (#/min)

R ref (Deg)

I ref (Kix)

T ref (DegC)

H ref (Hr)

G ref (m/s/s)

Z (#/min)

R (Deg)

I (KLx)

T (DegC)

G (m/s/s)

D (Hr)

S mod (S)

S circ (S)

S zerox (S)

S rms (S)

S temp (S)

S sleep (S)

S road (S)

S trip (S)

Minute Count (min) ..... Repeat 1 .. N(min)

AlarmState

SteeringMode

Acceleration [1](m/s/s) Wheel[1](Deg)

Acceleration [50] Wheel[50]

DQC (Data Quality Code 0..255)

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Table 23

**Data File Structure - Learn Mode Data File [XLEARN]\*.CSV**

Note : These files in external readable format - CSV

**Data File Structure - User Data File [XUSER]\*.CSV**

Note : These files in external readable format - CSV

UserID

File Creation Date

UserName

UserDoB

UserSex